Signal Processing and Interference Mitigation Strategies in NASA'S High Resolution Microwave Survey Project Sky Survey[*]

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The NASA High Resolution Microwave Survey (HRMS) project's Sky Survey is one of two complementary strategies NASA is using to search for evidence of extraterrestrial technology. The Sky Survey will observe a simultaneous dual-polarization bandpass of at least 300 MHz at a frequency resolution of 19 Hz as it performs its primary objective of searching the entire sky for extraterrestrial narrow band signals over the 1 GHz to 10 GHz frequency range. The system will be sensitive at the one-sigma level to RF inputs of from $1 \times 10\text{-}21$ to 3×10^{-21} *Watts* at the antenna feed. The survey will use existing radio telescopes, including NASA's Deep Space Network (DSN) 34-meter antennas for a search period of approximately 6 years, This paper will discuss the algorithms and hardware in the currently deployed 40 MHz Sky Survey prototype system and those planned for the full bandwidth operational system. The varying interference environment across the 1 to 10 GHz survey bandpass necessitates extensive interference mitigation, The RF system is designed with a wide dynamic range to pass the full bandwidth to the spectrum analyzer without spreading radio frequency interference (RF]) signals into uncorrupted frequencies. The planned operational system will use slightly different preprocessing from the prototype to produce a polyphase-DFT filter bank spectrometer whereas the prototype system uses a windowed FFT. The enhanced sidelobe rejection of the polyphase-DFT filter bank will not only isolate spectrally the effects of RFI, but will also improve the sensitivity of the system to weak signals in noise. The presence of RF] in the wideband input also challenges real-time dynamic noise power estimation, required for constant false-alarm-rate signal detection. An RFI-robust noise power estimate is computed using order statistics to sample the probability distribution function of the noise. Ordinarily, obtaining order statistics would require real-time sorting or histogramming of the input data stream, but the high data throughput in the HRMS Sky Survey makes this impractical. The prototype system employs a two-level hardware histogramming technique to obtain specific order statistics. In the operational system, however, by limiting the dynamic range within which the noise power is to be estimated, simple I/O efficient techniques based on a priori estimates can be used. Finally, RFI passing the detection filters is dealt with by a combination of software algorithms and frequency masking hardware.